PCT/EP04/10020

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Certifying Officer

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PATENT APPLICATION SERIAL NO. ____________________

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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☐ *Additional inventors are being named on the ______ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

PROCESS FOR THE ISOMERIZATION OF METALLOCENE COMPOUNDS

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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PATENT TRADEMARK OFFICE

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ENCLOSED APPLICATION PARTS *(check all that apply)*

- ☑ Specification *Number of Pages* 18
- ☐ Drawing(s) *Number of Sheets* ___
- ☐ Application Data Sheet. See 37 CFR 1.76
- ☐ CD(s), Number ___
- ☐ Other (specify) ___

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

- ☐ Applicant claims small entity status. See 37 CFR 1.27.
- ☐ A check or money order is enclosed to cover the filing fees
- ☑ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 08-2336
- ☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE AMOUNT ($): $160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

- ☑ No.
- ☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______

Respectfully submitted,

SIGNATURE William R. Reid

Date 10/09/2003

TYPED or PRINTED NAME William R. Reid

REGISTRATION NO. *(if appropriate)* 47,894

TELEPHONE 410-996-1783

Docket Number: FE 6135 (US)

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

EXPRESS MAILING CERTIFICATE

This certifies that the attached **Form PTO/SB/16** (in duplicate), **Specification (18 pages)** for the provisional application of **Simona Guidotti** et al., **PROCESS FOR THE ISOMERIZATION OF METALLOCENE COMPOUNDS** (our ref: **FE 6135 (US)**) is being mailed by "Express Mail Post Office to Addressee" service in an envelope addressed:

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PROCESS FOR THE ISOMERIZATION OF METALLOCENE COMPOUNDS

The present invention relates to a process for the conversion of the meso or meso-like form of a metallocene compound to the corresponding racemic or racemic-like form. The meso or the meso-like form to be subjected to the process of the invention can be admixed with the corresponding racemic (rac) or racemic-like form.

Metallocene compounds are well known complexes, mainly used as catalyst components for the polymerization of olefins. Processes for the synthesis of such metallocene compounds tend to produce mixtures of racemic and meso form. Usually the racemic form produces stereoregular polymers while the meso form is inactive or produces low molecular weight atactic polymers. The racemic form is therefore the most used as polymerization catalyst component. Consequently it is desirable to obtain from the synthesis the racemic (rac) form or a mixture where the racemic form is predominant in order to reduce the work for the physical separation of the two isomers.

EP 819 695 describes a process for the modification of the rac/meso ratio of a rac/meso mixture of a stereorigid bridged metallocene compounds by subjecting the mixture to a selective decomposition in the presence of compounds having either acidic hydrogen atoms or reactive halogen atoms, such as water, methanol, chlorotrimethylsilane. With this process, one isomeric form is decomposed with a consequently lowering of the overall yield of the process.

WO 00/017213 describes an isomerization process in which the meso form or a mixture of racemic and meso form of a bridged metallocene compound is contacted with a Group 1 and/or 2 metal halide isomerization catalyst in a liquid medium. This process has the drawback that the elimination of the metal halide from the reaction mixture could be complicated.

Organometallics 1998, 17, 1946-4958 describes a series of reactions in which rac-dimethylsilyl(1,3-diisopropylcyclopentadienyl)scandium allyl is isomerized to a rac/meso mixtures by using different isomerization catalysts. Among all $(n\text{-}C_7H_{15})_4NCl$ and $(n\text{-}C_7H_{15})_4NBr$ are used. This isomerization reaction is obviously not useful for an industrial process which target is to obtain the rac isomer. Moreover, on page 4953 of this document it is stated that the isomerization is discouraged for metallocenes of group 4, thus creating a prejudice in using this kind of reaction with metallocene compounds in which the central metal belongs to group 4 of the periodic table of the elements.

Thus it is desirable to find an alternative isomerization process that allows isomerizing the meso or meso-like form of a bridged metallocene compounds in the rac or rac-like form in an easy way.

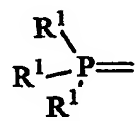
An object of the present invention is an isomerization process comprising the step of contacting a slurry or a solution comprising the meso or meso-like form of one or more bridged metallocene compounds of group 4 of the Periodic Table of the Elements having C_2 or C_2-like symmetry with an isomerization catalyst of formula (I)

$$[R_4W]^+X^- \quad (I)$$

wherein:

W is a nitrogen or a phosphorus atom; preferably W is nitrogen;

R, equal to or different from each other, are C_1-C_{40} hydrocarbon radicals optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; two R can also join to form a saturated or unsaturated C_5-C_6 membered cycle containing the atom W to form for example a pyrrollyl, a pirrolydinyl or a pyperidinyl radical or two R can also join to form a radical of formula (II)



(II)

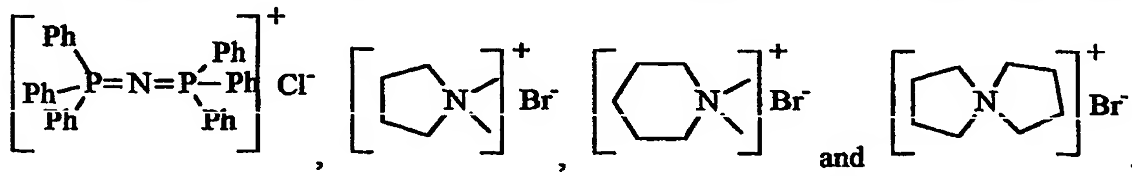
wherein R^1, equal to or different from each other, are C_1-C_{20} hydrocarbon radicals optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; preferably R^1 are linear or branched, cyclic or acyclic, C_1-C_{12}-alkyl, C_2-C_{12} alkenyl, C_2-C_{12} alkynyl, C_6-C_{12}-aryl, C_7-C_{12}-alkylaryl or C_7-C_{12}-arylalkyl radicals; P is a phosphorous atom bonded with a double bond to the atom W; preferably R are linear or branched, cyclic or acyclic, C_1-C_{40}-alkyl, C_2-C_{40} alkenyl, C_2-C_{40} alkynyl, C_6-C_{40}-aryl, C_7-C_{40}-alkylaryl or C_7-C_{40}-arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

more preferably R is a C_1-C_{40}-alkyl, C_6-C_{40}-aryl or C_7-C_{40}-alkylaryl radical, such as n-butyl, n-hexyl, phenyl and benzyl (Bz) radicals; and

X^- is an halide atom such as Cl^-, Br^-, I^-, F^-, preferably X^- is chloride (Cl^-) or bromide (Br^-).

Examples of compounds of formula (I) are $(CH_3(CH_2)_3)_4NBr$, $(CH_3(CH_2)_5)_4NBr$,

$(CH_3CH_2)_3(C_6H_5CH_2)NBr$, $(CH_3(CH_2)_3)_4NCl$, $(CH_3CH_2)_3(C_6H_5CH_2)NCl$, $(CH_3(CH_2)_3)_4PBr$, $(CH_3(CH_2)_5)_4PBr$, $(CH_3CH_2)_3(C_6H_5CH_2)PBr$, $(CH_3(CH_2)_3)_4PCl$, $(CH_3CH_2)_3(C_6H_5CH_2)PCl$,

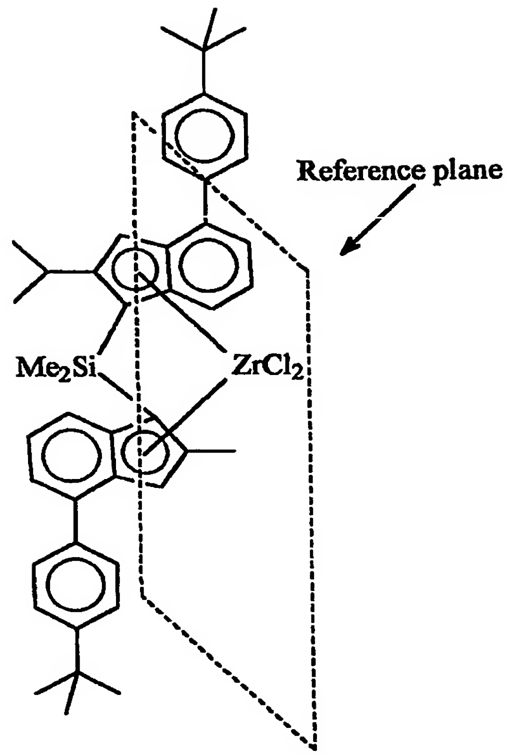


The bridged metallocene compounds of group 4 of the Periodic Table of the Elements having C_2 or C_2-like symmetry have two bridged cyclopentadienyl moieties linked to the central metal atom trough a π bond. The central metal atom is zirconium, titanium or hafnium, preferably zirconium.

For the purpose of the present invention, the term "C_2 symmetry" means that in the metallocene compound two isomeric forms are possible, the racemic and the meso forms. These isomeric forms are well known in the art for example they are cited in *Chem. Rev.* **2000,** *100,* 1253-1345.

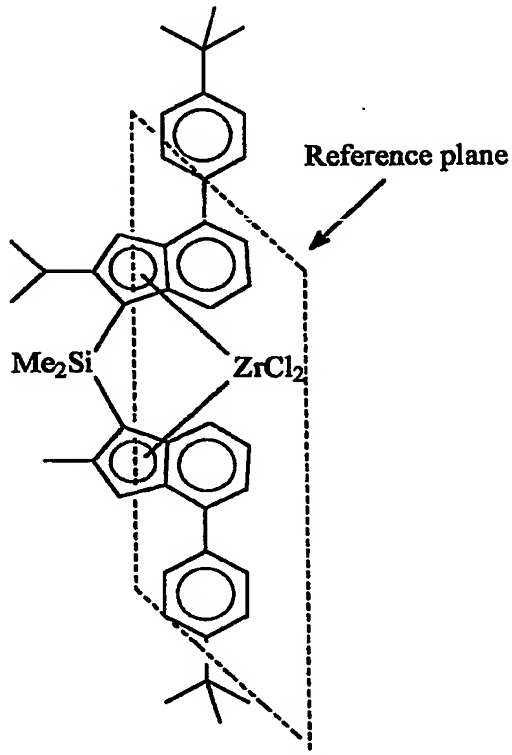
For the purpose of the present invention, the term "C_2-like symmetry" means that in the metallocene compound two isomeric forms are possible, the racemic-like and the meso-like form.

"Racemic-like form" means that the bulkier substituents of the two cyclopentadienyl moieties on the metallocene compound are on the opposite sides with respect to the plane containing the zirconium and the centre of the cyclopentadienyl moieties as shown in the following compound.



racemic-like form

Conversely meso-like form means that the bulkier substituents of the two cyclopentadienyl moieties on the metallocene compound are on the same side with respect to the plane containing the zirconium and the centre of the cyclopentadienyl moieties as shown in the following compound.



meso-like form

With the process of the present invention the meso or meso-like form of one or more bridged metallocene compounds of group 4 of the Periodic Table of the Elements having C_2 or C_2-like symmetry can be used alone or in a mixture comprising the racemic or racemic-like form.

According to a preferred embodiment, the process of the present invention is carried out in an aprotic solvent, either polar or apolar. Said aprotic solvent can be an aromatic or aliphatic hydrocarbon, optionally halogenated or optionally containing heteroatoms belonging to the group 16 of the periodic table, or an ether. Preferably it is selected from the group consisting of benzene, toluene, pentane, hexane, heptane, cyclohexane, dichloromethane, chlorobenzene, diethylether, tetrahydrofuran, 1,2 dimethoxyethane N,N-dimethylformamide, dimethyl sulfoxide or mixtures thereof. Preferably the process of the present invention is carried out in the presence of one or more ethers such as tetrahydrofuran or 1,2 dimethoxyethane; more preferably the solvent contains at least 5% by volume of one or more ethers.

The process of the present invention can be carried out at a temperature ranging from 0°C to a temperature below the temperature of decomposition of the bridged metallocene compound in the selected solvent, usually up to 180°C. Preferably the process of the present invention is carried out

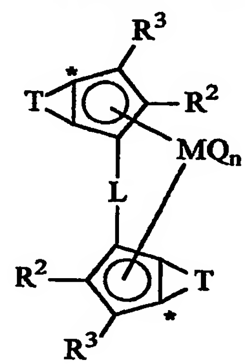
at a temperature ranging from 10°C to 150°C, more preferably from 30°C to 90°C, even more preferably from 40°C to 90°C.

The molar ratio between the isomerization catalyst and the metal of the bridged metallocene compound is preferably comprised between 0.01 to 300; more preferably the ratio is from 0.01 to 100, even more preferably from 0.1 to 10; particularly preferred ratio range is from 0.2 to 5.

With the process of the present invention it is possible to convert at least part of the meso or meso-like form to the racemic or racemic-like form of a bridged metallocene compound. This allows to improve the final yield in term of the racemic or racemic-like isomer of the whole process for synthesising the target metallocene compound. The removal of the isomerization catalyst and the final purification of the racemic or racemic like isomer can be carried out according to the procedure commonly used in the art.

The process of the present invention can be used as such or it can be part of a one-pot process for obtaining metallocene compounds starting from the ligands, such as the processes described in EP 03101268.5; WO 03/057705; WO 99/36427 and WO 02/083699.

Bridged metallocene compounds having C_2 symmetry or C_2-like symmetry that can be used in the process of the present invention are preferably compounds of formula (III)



(III)

wherein:

M is a transition metal belonging to group 4, preferably M is zirconium, or hafnium;

the substituents Q, equal to or different from each other, are monoanionic sigma ligands selected from the group consisting of hydrogen, halogen, R^8, OR^8, $OCOR^8$, SR^8, NR^8_2 and PR^8_2, wherein R^8 is a linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-

aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radical optionally containing one or more Si or Ge atoms;

or two Q can optionally form a substituted or unsubstituted butadienyl radical or a OR'O group wherein R' is a divalent radical selected from C_1-C_{20} alkylidene, C_6-C_{40} arylidene, C_7-C_{40} alkylarylidene and C_7-C_{40} arylalkylidene radicals;

the substituents Q are preferably the same and are preferably halogen atoms, R^8, OR^8 and NR^8_2; wherein R^8 is preferably a C_1-C_{10} alkyl, C_6-C_{20} aryl or C_7-C_{20} arylalkyl group, optionally containing one or more Si or Ge atoms; more preferably, the substituents Q are selected from the group consisting of -Cl, -Br, -Me, -Et, -n-Bu, -sec-Bu, -Ph, -Bz, $-CH_2SiMe_3$, -OEt, -OPr, -OBu, -OBz and $-NMe_2$;

n is an integer equal to the oxidation state of the metal M minus 2;

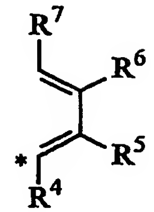
L is a divalent bridging group selected from C_1-C_{20} alkylidene, C_3-C_{20} cycloalkylidene, C_6-C_{20} arylidene, C_7-C_{20} alkylarylidene, or C_7-C_{20} arylalkylidene radicals optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements, and silylidene radical containing up to 5 silicon atoms such as $SiMe_2$, $SiPh_2$; preferably L is a divalent group $(ZR^9_m)_q$; Z being C, Si, Ge, N or P, and the R^9 groups, equal to or different from each other, being hydrogen or a linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radical or two R^9 can form a aliphatic or aromatic C_4-C_7 ring; preferably R^9 is a hydrogen atom or a methyl or phenyl radical; preferably Z is Si or C;

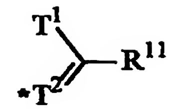
m is 1 or 2, and more specifically it is 1 when Z is N or P, and it is 2 when Z is C, Si or Ge; q is an integer ranging from 1 to 4; preferably q is 1 or 2;

more preferably L is selected from $Si(CH_3)_2$, $SiPh_2$, SiPhMe, $SiMe(SiMe_3)$, CH_2, $(CH_2)_2$, $(CH_2)_3$ or $C(CH_3)_2$;

R^2, R^3, equal to or different from each other, are hydrogen atoms, halogen atoms or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

T, equal to or different from each other, is a moiety of formula (IIIa) or (IIIb):





(IIIa) (IIIb)

wherein:

the atom marked with the symbol * bonds the atom marked with the same symbol in the compound of formula (III);

T^1 is a sulphur atom, a oxygen atom or a CR^{10}_2 or a NR^{12} group, wherein R^{10}, equal to or different from each other, are hydrogen atoms, halogen atoms or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; and R^{12} is a or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radical, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; preferably T^1 is sulphur.

T^2 is a CR^{10} group or a nitrogen atom; wherein R^{10} is a hydrogen atom, a halogen atom or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radical, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; preferably T^2 is a CR^{10} group;

with the proviso that if T^2 is a nitrogen atom T^1 is CR^{10}_2;

R^4, R^5, R^6, R^7, and R^{11}, equal to or different from each other, are hydrogen atoms, halogen atoms or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; or two adjacent R^4, R^5, R^6, R^7, R^{10} and R^{11} form one or more 3-7 membered ring optional containing heteroatoms belonging to groups 13-17 of the periodic table;

preferably R^2 and R^{11}, equal to or different from each other, are linear or branched C_1-C_{20}-alkyl radicals, such as methyl, ethyl or isopropyl radicals;

preferably R^4 and R^{10}, equal to or different from each other, are hydrogen atoms ir C_6-C_{20}-aryl, or C_7-C_{20}-arylalkyl radicals such as phenyl, 4-tert-butyl phenyl radicals.

Non limiting examples of compounds belonging to formula (I) are the following compounds;

~~dimethylsilanediylbis(indenyl)zirconium dichloride,~~
dimethylsilanediylbis(2-methyl-4-phenylindenyl)zirconium dichloride,
dimethylsilanediylbis(4-naphthylindenyl)zirconium dichloride,
dimethylsilanediylbis(2-methylindenyl)zirconium dichloride,
dimethylsilanediylbis(2-methyl-4-t-butylindenyl)zirconium dichloride,
dimethylsilanediylbis(2-methyl-4-isopropylindenyl)zirconium dichloride,
dimethylsilanediylbis(2,4-dimethylindenyl)zirconium dichloride,
dimethylsilanediylbis(2-methyl-4,5-benzoindenyl)zirconium dichloride,
dimethylsilanediylbis(2,4,7-trimethylindenyl)zirconium dichloride,
dimethylsilanediylbis(2,4,6-trimethylindenyl)zirconium dichloride,
dimethylsilanediylbis(2,5,6-trimethylindenyl)zirconium dichloride,
methyl(phenyl)silanediylbis(2-methyl-4,6-diisopropylindenyl)-zirconium dichloride,
methyl(phenyl)silanediylbis(2-methyl-4-isopropylindenyl)-zirconium dichloride,
1,2-ethylenebis(indenyl)zirconium dichloride,
1,2-ethylenebis(4,7-dimethylindenyl)zirconium dichloride,
1,2-ethylenebis(2-methyl-4-phenylindenyl)zirconium dichloride,
1,4-butanediylbis(2-methyl-4-phenylindenyl)zirconium dichloride,
1,2- ethylenebis(2-methyl-4,6-diisopropylindenyl)zirconium dichloride,
1,4-butanediylbis(2-methyl-4-isopropylindenyl)zirconium dichloride,
1,4-butanediylbis(2-methyl-4,5-benzoindenyl)zirconium dichloride,
1,2- ethylenebis (2-methyl-4,5-benzoindenyl)zirconium dichloride,
dimethylsilanediylbis-6-(3-methylcyclopentadienyl-[1,2-b]-thiophene) dichloride;
dimethylsilanediylbis-6-(4-methylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;
dimethylsilanediylbis-6-(4-isopropylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;
dimethylsilanediylbis-6-(4-ter-butylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;
dimethylsilanediylbis-6-(3-isopropylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;
dimethylsilanediylbis-6-(3-phenylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;

dimethylsilanediylbis-6-(2,5-dichloride-3-phenylcyclopentadienyl-[1,2-b]-thiophene)zirconium dimethyl;

dimethylsilanediylbis-6-[2,5-dichloride-3-(2-methylphenyl)cyclopentadienyl-[1,2-b]-thiophene]zirconium dichloride;

dimethylsilanediylbis-6-[2,5-dichloride-3-(2,4,6-trimethylphenyl)cyclopentadienyl-[1,2-b]-thiophene]zirconium dichloride;

dimethylsilanediylbis-6-[2,5-dichloride-3-mesitylenecyclopentadienyl-[1,2-b]-thiophene]zirconium dichloride;

dimethylsilanediylbis-6-(2,4,5-trimethyl-3-phenylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;

dimethylsilanediylbis-6-(2,5-diethyl-3-phenylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;

dimethylsilanediylbis-6-(2,5-diisopropyl-3-phenylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;

dimethylsilanediylbis-6-(2,5-diter-butyl-3-phenylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;

dimethylsilanediylbis-6-(2,5-ditrimethylsilyl-3-phenylcyclopentadienyl-[1,2-b]-thiophene)zirconium dichloride;

dimethylsilanediylbis-6-(3-methylcyclopentadienyl-[1,2-b]-silole)zirconium dichloride;

dimethylsilanediylbis-6-(3-isopropylcyclopentadienyl-[1,2-b]-silole)zirconium dichloride;

dimethylsilanediylbis-6-(3-phenylcyclopentadienyl-[1,2-b]-silole)zirconium dichloride;

dimethylsilanediylbis-6-(2,5-dichloride-3-phenylcyclopentadienyl-[1,2-b]-silole)zirconium dichloride;

dimethylsilanediylbis-6-[2,5-dichloride-3-(2-methylphenyl)cyclopentadienyl-[1,2-b]-silole]zirconium dichloride;

dimethylsilanediylbis-6-[2,5-dichloride-3-(2,4,6-trimethylphenyl)cyclopentadienyl-[1,2-b]-silole]zirconium dichloride;

dimethylsilanediylbis-6-[2,5-dichloride-3-mesitylenecyclopentadienyl-[1,2-b]-silole]zirconium dichloride;

dimethylsilanediylbis-6-(2,4,5-trimethyl-3-phenylcyclopentadienyl-[1,2-b]-silole)zirconium dichloride;

Dimethylsilanediylbis(2-methyl-4-p-tert-butylphenylindenyl)zirconium dichloride;
Dimethylsilanediyl(2-isopropyl-4-p-tert-butylphenylindenyl)(2-methyl-4-p-tert-butylphenylindenyl)zirconium dichloride;
Dimethylsilanediyl(2-isopropyl-4-p-tert-butylphenylindenyl)(2-methyl-4-p-tert-butyl-7-methylphenylindenyl)zirconium dichloride;
as well as the corresponding zirconium dimethyl, hydrochloro dihydro and η^4-butadiene compounds.

The following examples are given to illustrate and not to limit the invention.

Examples

Dimethylsilanediyl [2-methyl-4-(4'-*tert*-butylphenyl)indenyl] [2-isopropyl-4-(4'-*tert*-butylphenyl)indenyl)] dimethyl zirconium (A) is prepared following the same procedure described in example 5 of PCT/EP02/14899 by using [2-methyl-4-(4'-*tert*-butylphenyl)indenyl] [2-isopropyl-4-(4'-*tert*-butylphenyl)indenyl)]dimethylsilane instead of bis(2-methyl-indenyl)dimethylsilane.

Dimethylsilanediylbis[2-methyl-4,5-benzo-1-indenyl] dimethyl zirconium (B) was prepared according to US 6,177,376.

Dimethylsilanediylbis[2-methyl-4,5-benzo-1-indenyl] zirconium dichloride (C) was prepared according to US 5,830,821.

Examples 1-7 General procedure.

A purified *meso* enriched metallocene was dissolved (or slurried) at room temperature in the solvent indicated in table 1. The isomerization catalyst specified in table 1 was added and then the mixture was heated for few hours. NMR analysis of a sample of the resulting solution (or slurry) showed that the *rac/meso* ratio of the metallocene was substantially improved in favour of the *rac* isomer. The latter was also isolated in higher yields compared with the yields achieved by using standard procedures.

The *rac/meso* ratios were determined by NMR analysis. The proton spectra of metallocenes were obtained on a Bruker DPX 200 spectrometer operating in the Fourier transform mode at room temperature at 200.13 MHz. The samples were dissolved in CD_2Cl_2 (Aldrich, 99.8 atom % D); preparation of the samples was carried out under nitrogen using standard inert atmosphere techniques. The residual peak of $CHDCl_2$ in the ^1H spectra (5.35

ppm) was used as a reference. Proton spectra were acquired with a 15° pulse and 2 seconds of delay between pulses; 32 transients were stored for each spectrum.

Table 1

Ex.	Met.	starting *rac/meso* ratio	Isomerization catalyst (n° eq./Zr)	Solvent	T (°C)	t (h)	final *rac/meso* ratio
1	A	2.4/97.6	*n*-Bu_4NBr (0.22/1)	THF	65	5	94.0/6.0
2	A	31.7/68.3	*n*-Bu_4NBr (0.21/1)	toluene,THF 1/1.7 v/v	80	4	78.9/21.1
3	A	31.7/68.3	$[CH_3(CH_2)_5]_4NBr$ (0.23/1)	toluene,THF 1/1.7 v/v	80	10	76.5/23.5
4	A	31.7/68.3	$(CH_3CH_2)_3BzNCl$ (0.23/1)	toluene,THF 1/1.7 v/v	80	4	75.2/24.8
5	B	26.8/73.2	*n*-Bu_4NBr (0.22/1)	THF	65	2	71.9/28.1
6	C	17.7/82.3	*n*-Bu_4NBr (0.23/1)	THF	65	2.5	94.4/5.6
7	A	33.3/66.7	*n*-Bu_4NBr (0.21/1)	chlorobenzene	80	7.5	70.4/29.6
8	A	33.3/66.7	Et_3BzNCl (0.21/1)	toluene	80	3	61.5/38.5

note:

no remarkable amount of decomposition was observed.

Et = ethyl radical n-Bu= normal butyl radical; Bz= benzil radical

Comparative example 1.

A sample of ammonium chloride (Aldrich, MW 53.49) was dried at 125°C for 8 h under vacuum. An aliquot of this sample (Aldrich, 17.0 mg, 0.32 mmol, NH_4Cl/dimethyl complex = 0.20/1) was added at room temperature under nitrogen atmosphere to a solution of 1.16 g of dimethylsilanediyl[2-methyl-4-(4'-*tert*-butylphenyl)indenyl][2-isopropyl-4-(4'-*tert*butylphenyl)indenyl)] dimethyl zirconium (*rac/meso* 31.7/68.3, MW = 728.26, 1.59 mmol) in 25 mL of THF and 15 mL of toluene in a 50 mL Schlenk flask. At the end of the addition, the reaction mixture was heated at 80°C for 2.5 h and followed by NMR analysis: the *rac/meso* ratio resulted to be 34/66 and a small amount of decomposition to the ligand was also observed. Additional ammonium chloride (100.0 mg, 1.87 mmol, total NH_4Cl/dimethyl complex = 1.38/1) was added at room temperature and then the resulting mixture was heated at 80°C for 3.5 h. Different aliquots of the mixture were taken, dried and analysed by ^1H NMR in CD_2Cl_2. The final *rac/meso* ratio resulted to be 45/55 and a remarkable amount of decomposition to the ligand (ca. 20% mol. calculated by NMR) was also observed.

Comparative example 2.

A sample of triethylammine hydrochloride (Aldrich, 98%, MW 137.65, 25.7 mg, 0.18 mmol, $NHEt_3Cl$/dimethyl complex = 0.22/1) was suspended at room temperature into 5 mL of THF and added under nitrogen atmosphere to a suspension of 0.58 g of dimethylsilanediyl[2-methyl-4-(4'-*tert*-butylphenyl)indenyl][2-isopropyl-4-(4'-*tert*butylphenyl)indenyl)] dimethyl zirconium (*rac/meso* 30/70, MW = 728.26, 0.80 mmol) in 15 mL of THF in a 50 mL Schlenk flask. At the end of the addition, the reaction mixture was heated at reflux for 2 h and followed by NMR analysis: the *rac/meso* ratio resulted to be 45/55, but a remarkable amount of decomposition was also observed. The heating was then continued for additional 2 h, but no change in the *rac/meso* ratio was observed by NMR analysis.

CLAIMS

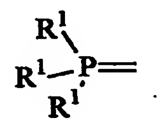
1. An isomerization process comprising the step of contacting a slurry or a solution comprising the meso or meso-like form of one or more bridged metallocene compounds of group 4 of the Periodic Table of the Elements having C_2 or C_2-like symmetry with an isomerization catalyst of formula (I)

$$[R_4W]^+X^- \quad (I)$$

wherein:

W is a nitrogen or a phosphorus atom;

R, equal to or different from each other, are C_1-C_{40} hydrocarbon radicals optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; two R can also join to form a saturated or unsaturated C_5-C_6 membered cycle containing the atom W or two R can also join to form a radical of formula (II)



(II)

wherein R^1, equal to or different from each other, are C_1-C_{20} hydrocarbon radicals optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; P is a phosphorous atom bonded with a double bond to the atom W; and

X^- is an halide atom.

2. The isomerization process according to claim 1 wherein a mixture comprising the meso or meso-like form and the racemic or racemic-like form of one or more bridged metallocene compounds of group 4 of the Periodic Table of the Elements having C_2 or C_2-like symmetry is used.

3. The isomerization process according to claims 1-2 wherein R are linear or branched, cyclic or acyclic, C_1-C_{40}-alkyl, C_2-C_{40} alkenyl, C_2-C_{40} alkynyl, C_6-C_{40}-aryl, C_7-C_{40}-alkylaryl or C_7-C_{40}-arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; two R can also join to form a saturated or unsaturated C_5-C_6 membered cycle containing the atom W; and X^- is chloride (Cl^-) or bromide (Br^-).

4. The isomerization process according to anyone of claims 1-3 wherein W is a nitrogen atom.

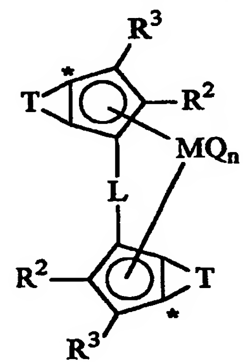
5. The isomerization process according to anyone of claims 1-4 wherein the process is carried out in an aprotic solvent, either polar or apolar.

6. The isomerization process according to claim 5 wherein the aprotic solvent is an aromatic or aliphatic hydrocarbon, optionally halogenated or optionally containing heteroatoms belonging to the group 16 of the periodic table, or an ether.

7. The isomerization process according to claim 6 wherein the process is carried out in the presence of one or more ethers.

8. The isomerization process according to anyone of claims 1-7 wherein the process is carried out at a temperature ranging from 0 to a temperature below the temperature of decomposition of the bridged metallocene compound in the selected solvent.

9. The isomerization process according to anyone of claims 1-8 wherein the bridged metallocene compounds having C_2 symmetry or C_2-like symmetry has formula (III)



(III)

wherein:

M is a transition metal belonging to group 4,

the substituents Q, equal to or different from each other, are monoanionic sigma ligands selected from the group consisting of hydrogen, halogen, R^8, OR^8, $OCOR^8$, SR^8, NR^8_2 and PR^8_2, wherein R^8 is a linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radical optionally containing one or more Si or Ge atoms;

or two Q can optionally form a substituted or unsubstituted butadienyl radical or a $OR'O$ group wherein R' is a divalent radical selected from C_1-C_{20} alkylidene, C_6-C_{40} arylidene, C_7-

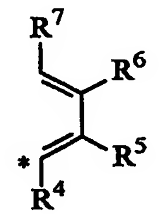
C_{40} alkylarylidene and C_7-C_{40} arylalkylidene radicals;

n is an integer equal to the oxidation state of the metal M minus 2;

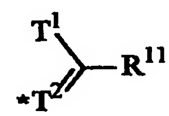
L is a divalent bridging group selected from C_1-C_{20} alkylidene, C_3-C_{20} cycloalkylidene, C_6-C_{20} arylidene, C_7-C_{20} alkylarylidene, or C_7-C_{20} arylalkylidene radicals optionally containing heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements, and silylidene radical containing up to 5 silicon atoms;

R^2, R^3, equal to or different from each other, are hydrogen atoms, halogen atoms or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

T, equal to or different from each other, is a moiety of formula (IIIa) or (IIIb):



(IIIa)



(IIIb)

wherein:

the atom marked with the symbol * bonds the atom marked with the same symbol in the compound of formula (III);

T^1 is a sulphur atom, a oxygen atom or a $CR^{10}{}_2$ or a NR^{12} group, wherein R^{10}, equal to or different from each other, are hydrogen atoms, halogen atoms or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; and R^{12} is a or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radical, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements;

T^2 is a CR^{10} group or a nitrogen atom; wherein R^{10} is a hydrogen atom, a halogen atom or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-

aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radical, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; with the proviso that if T^2 is a nitrogen atom T^1 is $CR^{10}{}_2$; R^4, R^5, R^6, R^7, and R^{11}, equal to or different from each other, are hydrogen atoms, halogen atoms or linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radicals, optionally containing one or more heteroatoms belonging to groups 13-17 of the Periodic Table of the Elements; or two adjacent R^4, R^5, R^6, R^7, R^{10} and R^{11} form one or more 3-7 membered ring optional containing heteroatoms belonging to groups 13-17 of the periodic table.

10. The isomerization process according to claim 9 wherein in the compound of formula (III) M is zirconium, or hafnium; the substituents Q are the same and are halogen atoms, R^8, OR^8 and $NR^8{}_2$; wherein R^8 is preferably a C_1-C_{10} alkyl, C_6-C_{20} aryl or C_7-C_{20} arylalkyl group, optionally containing one or more Si or Ge atoms; L is a divalent group $(ZR^9{}_m)_q$; Z being C, Si, Ge, N or P, and the R^9 groups, equal to or different from each other, being hydrogen or a linear or branched, cyclic or acyclic, C_1-C_{20}-alkyl, C_2-C_{20} alkenyl, C_2-C_{20} alkynyl, C_6-C_{20}-aryl, C_7-C_{20}-alkylaryl or C_7-C_{20}-arylalkyl radicals or two R^9 can form a aliphatic or aromatic C_4-C_7 ring.

11. The isomerization process according to claims 9-10 wherein in the compound of formula (II) R^2 and R^{11}, equal to or different from each other are linear or branched C_1-C_{20}-alkyl radicals; R^4 and R^{10}, equal to or different from each other, are hydrogen atoms or C_6-C_{20}-aryl, or C_7-C_{20}-arylalkyl radicals; T^1 is sulphur and T^2 is a CR^{10} group.

Abstract

An isomerization process comprising the step of contacting a slurry or a solution comprising the meso or meso-like form of one or more bridged metallocene compounds of group 4 of the Periodic Table of the Elements having C_2 or C_2-like symmetry with an isomerization catalyst of formula (I)

$$[R_4W]^+X^- \quad (I)$$

wherein:

W is a nitrogen or a phosphorus atom; R, equal to or different from each other, are C_1-C_{40} hydrocarbon radicals and X^- is an halide atom.